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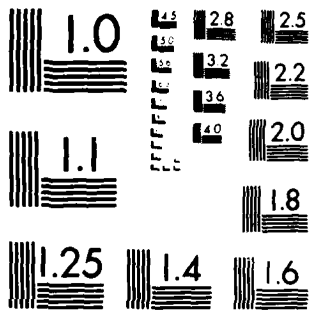

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This paper begins by defining those characteristics of careers in high technology that might be problematic for minorities, such as organizational procedures of recruitment and criteria for promotion, individual motivations, and career orientations. It describes four routes of career progression in R&D labs: 1) managerial, 2) technical, 3) project-to-project, and 4) technical transfer. The next section details an individual case study of a black engineer employed in central R&D lab of successful company. Paper concludes with implications for organizational career procedures and suggestions for future research.

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Careers in High Technology:
Notes on Technical Career Progression with Special Reference to *Possible Issues* for Minorities

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Massachusetts Institute of Technology

January, 1984

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ABSTRACT

This paper begins by defining those characteristics of careers in high technology that might be problematic for minorities. These concern organizational procedures of recruitment and the criteria for promotion, as well as individual motivations and career orientations. It then proceeds to describe four routes of career progression in R&D labs: 1) managerial, 2) technical, 3) from project to project, and 4) technical transfer. The next section details an individual case study of a black engineer employed by the central R&D lab of a successful company. The paper concludes with implications for organizational career procedures and suggestions for future research.

CAREERS IN HIGH TECHNOLOGY: NOTES ON TECHNICAL CAREER PROGRESSION WITH SPECIAL REFERENCE TO POSSIBLE ISSUES FOR MINORITIES

Careers in high technology share some of the characteristics of all industrial careers but because of the type of work involved, as well as the highly specialized education of the workforce, they are characterized, also, by some unique features. I would like to start by mentioning those unique aspects of technical careers that may have a differential impact on minorities.

First, recruitment into these organizations is usually from universities and technical institutes, with grades and other academic qualifications playing an important role. The relevance of this for minority recruitment is evidenced by the concern of MIT and other technical universities about the disproportionate number of students entering electronic engineering and computer science. More and more universities are having to limit the entrance into these fields and are concerned that if in this process they depend only on academic credentials (grades and test scores) they may undercut their efforts to bring more minority students into these areas. To the extent that the recruitment process into high technology organizations depends on such criteria, there may be similar difficulties there.[1] Further, in many high technology organizations "academic" criteria continue to be used for initial evaluations of performance, and sometimes even for first promotions and subsequent advancement. This characteristic of the recruitment process, therefore, may have longer-range consequences than merely initial hiring.

Another characteristic, unique to technical careers, is the complicated and not easily defined relation of technical expertise to responsibility and

authority. In high technology organizations the boundary between supervision and the technical workforce tends to be blurred. Procedures define supervision as the locus of technical expertise since it is there that authorization and sign-off on technical work take place. The actuality, though, is usually different, with the real technical competence residing in the workforce. Thus technical goals are not often achieved by direct command. They are reached, rather, through personal example, specific efforts at coordination, and other modes of informal and informed influence and access to resources. Careers in high technology, therefore, evolve in a setting that is fluid and full of ambiguity. It is a setting that should provide optimal opportunity for individual influence and innovative action (Kanter, 1983). To function effectively in such a setting, however, requires knowledge of existing networks and sources of information, as well as a sense of control over events: an expectation that favorable outcomes follow individual effort in a predictable manner. And it is just such knowledge and sense of control that may be difficult for minority workers to attain.

In an amorphous setting, with unclear signals and ambiguous criteria to guide behavior, knowledge and control are not easy to acquire. Without specific socialization efforts, characteristically lacking in high technology organizations, newcomers initially rely on general cultural knowledge to help them decipher the new setting. A person entering from a culture different from that represented by the majority of the workforce may therefore be at a disadvantage, and may be significantly slower in gaining the necessary knowledge to maneuver successfully in that setting. Further, without clear specifications for successful performance, judgment of people tends to shift to more easily identified characteristics associated in the past with high performance. Here, too, minority workers may be at a disadvantage, since it

is less likely that they will share the characteristics perceived to be necessary.

Thus, the very features that make high technology organizations unique, and appealing and rewarding to many, may provide special hurdles for technical professionals outside the traditional mold.

It is important, also, to remember that employees in high technology enter with a variety of motivations and evolve a number of career orientations. Technical training is sought by people for many different reasons. All, presumably, have shown a talent for mathematics and science relatively early in their lives, but their reasons for pursuing this bent may vary. For simplicity, here, I would like to differentiate between two initial motivations:[2] (1) an intrinsic involvement with the field, a real enjoyment of technical problem solving, which elsewhere we have called technical puzzle orientation (Bailyn and Lynch, 1983); and (2) an interest in career, where the occupation is viewed as an avenue of mobility and thus attracts technically talented young people who see it as an entry into the world of middle-class professionals.[3] In one sample of white, male engineers at mid-career, for example, about one-third had a technical orientation (Bailyn, 1980; Bailyn and Lynch, 1983), though I suspect this figure would have been higher at entry into the career. It is an important empirical question whether the distribution of minority workers' motivations differs in any way from that of whites.

As people get experience in a career and learn more about their actual talents and interests, motivations merge with an evolving knowledge of skills and values to form career orientations, what my colleague Ed Schein has called career anchors. A career anchor (an occupational "self-concept" consisting of "self-perceived talents and abilities"; "self-perceived motives and needs";

and "self-perceived attitudes and values" --Schein, 1978, p. 125) is a joint product of initial motivation and self-knowledge gained from actual experience with the work in the field. Schein has repeatedly shown that knowledge of one's career anchor is crucial for satisfactory career progress. To what extent the feedback from the workplace necessary for this self-knowledge works as well for minorities as for white males is, therefore, a critical question.[4]

These, then, are the characteristics of careers in high technology that might make successful career progression problematic for minorities. True, once these employees reach fairly high levels they may have some special advantage. Kanter (1983), for example, has shown that non-traditional workers may in fact be more innovative, particularly in situations where there are organizational constraints on innovation. And I have had personal experience with a black middle manager in a complex organization who himself felt that his minority status has helped him to function effectively by giving him an "outsider's" sensitivity to the actual workings of that organization. The question remains, however, whether there are serious barriers to many minority employees reaching those positions where their non-traditional status might be an advantage.

Career Progression in R&D Labs

My recent work has centered on a sub-set of high technology careers, those in R&D labs. R&D careers take a number of different forms and evolve in a variety of different ways. The most easily described, and most usually defined as "successful," is the managerial route, which slowly moves a person away from technical work. It is the route that led Hughes (1958, p. 137) to

say that "the engineer who, at forty, can still use a slide rule or logarithmic table, and make a true drawing, is a failure." Because of this career disjunction in the "successful" managerial route, some organizations have tried to formalize, also, a <u>technical route</u>, where the employee "progresses" while still remaining involved in technical work. Recent work (McKinnon, 1980; Allen, in progress) has shown, however, that a number of R&D professionals neither desire nor expect promotion up a managerial or technical ladder and are involved, rather, in a career that evolves <u>from project to project</u>. Finally, a fourth career route--the <u>technical transfer route</u>--consists of transferring with technology: moving out of the) lab and into another part of the corporation. This path was described ne lab as a move "into other [non-research] parts of the company . . . The l basis for making such a move is to go with a new product or process."

Each of these career routes involves different issues and may present different problems for minority professionals.

<u>Managerial Route</u>

In the central R&D lab the managerial route is the most attractive because it carries with it the highest compensation and prestige, and because it often is the only way to have real influence on the technical work. Managers are assumed to be the most technically competent and are given the authority to make the technical decisions in the lab. It is an assumption, however, often contradicted by the reality of the R&D manager's actual situation. First, as managers move up they gain responsibility for a greater variety of technical projects, which makes it less and less likely that they can actually be expert in all the technologies or processes involved in the work for which they are responsible. Second, to be successful they necessarily must emphasize

administrative tasks: budgeting and the evaluation of people. They get involved in these tasks partly because they are more easily specified and monitored than is true for technical work. But primarily this shift is the result of the process of resource allocation in the R&D lab, which depends on managers at every level making their case in competition with others at the same level. Further, in those labs that are not fully centrally funded, managers must also bring in funds through government contracts or from "customers" (other parts of the lab or other units of the corporation) to which they have to "sell" their wares.

A number of difficulties stem from this contradiction between the technical expertise presumed to be necessary for managers in R&D and the actual tasks required by that role. Some people, rewarded for a particular technical accomplishment by promotion, discover that they have neither liking for nor ability in the administrative part of the supervisory role. Characteristically they stay as much involved in technical work as possible, which has negative consequences for their group and for the people they supervise. Such a group is deprived of a champion to fight for resources for its projects and for the individuals who are working on them. Even worse, such a technical expert may prevent the people of that group from showing their own technical expertise by allocating to himself (or herself) the most challenging technical tasks. It is just such situations that led professionals in a lab contemplating the introduction of a dual ladder system to lament that: "we already have a technical ladder; what we really need is a managerial ladder!"; and the chief engineer in another lab to comment that "you don't keep a dog and then bark yourself."

Others, of course, can manage this transition and slowly transform themselves into managers. (Though I have seen some who even at high

managerial levels still chafe at administrative duties and hanker after "real"—technical--work.) In one lab I studied, an innovative arrangement had evolved which might serve as a model of how to deal with this contradiction. In that lab the person who had been promoted was not the best technically but the one most willing and able to do the administrative tasks of management. The promotion for this man was more an assignment to a new set of tasks rather than a reward for technical excellence. In his group, however, there was a technical superstar who served as an informal co-leader. It was he who made the technical decisions for the group (though it came out as a joint decision), and he then pursued his scientific work, only participating in formal group activities when there were technical presentations for potential backers of the research. The manager took care of all the administrative tasks, managed the evaluation and development of the people in the group, and worried about getting the resources they needed. It was a successful arrangement which worked because the manager, who had no technical pretense, was proud of the expertise and competence of his "subordinate" and openly depended on him for technical advice, and because the scientist had no ambitions for a title and was financially rewarded in line with his actual level of authority, not with his formal hierarchical position. What such an arrangement requires therefore--besides mutual respect and trust between the people involved--is an accurate assessment of the orientations of technical professionals and personnel procedures that allow one to reward people in line with their performance at the tasks to which they are assigned, rather than with the particular formal position they occupy.

It is clear from this discussion that the ill-defined, amorphous prescriptions for successful performance, mentioned above as characteristic of

careers in high technology, are key issues in the managerial route. One generally gets promoted into these positions because of technical competence, but if one is to be successful one must then shift to new and different tasks for which no clear guidelines exist. One must learn how to have authority over and be accountable for work that is performed by others whose technical competence in a particular area is actually greater than one's own, in a situation where expertise is presumed to lie with the manager. Neither doing the technical work oneself nor delegating all the responsibilty will be successful. To find the right middle road takes an interpersonal and organizational sense that is not easy to acquire. And, as already mentioned, it may be particularly difficult for minorities, whose orientations and responses emerge in a different psychological and social context, to assess this situation and to learn, quickly, how to manage it.

Technical Route

The difficulties described above have led some companies to try to define a technical career route whereby "advancement" is possible without leaving technical tasks for management. As officially described by one company, this route consists of "maintaining responsibilities for one's own research while demonstrably increasing in technical achievement." Recognition, typically, consists of titles with associated salary increases and, occasionally, perqs. The difficulties in this route are inherent in the definition:

1. Here one "maintains" responsibility; the same company starts its description of the managerial route with the words "taking more responsibility" (emphasis added).

2. Increased technical achievement is "demonstrated through the usual 'peer review' process":—an academic judgment.

These two points are critical constraints on the functioning of a technical ladder. The first highlights the fact that technical "advancement" does not include any increase in authority--in organizational influence. In one company, for example, the route was informally known as a "rungless ladder": there are no rungs because nothing changes in one's work or organizational functioning as one moves up this ladder. It was described to me, rather, as a "continuum: no slots, and one does not have to wait for a position." Nor does movement along this continuum necessarily increase one's visibility or status, since the main change that results is an increase in salary. But such a change, which merges with general cost of living and seniority increases, is private and thus precludes the public recognition that accompanies a managerial promotion. And even title changes or visible changes in perqs are an ephemeral form of recognition if the working position remains the same: if no added responsibility or authority accompanies the move.

And so, some companies have tried to build an academic review process into their technical ladder. It is modeled on the university system, and the responsibilities of academics do not, in fact, change very much as they move up the academic ladder. In the industrial context, however, a different situation prevails. First, there are few top academic scientists in industrial labs, and those who exist are probably the very ones least in need of organizational recognition. Second, by not including the up or out characteristic of the university tenure decision, the introduction of academic judgment creates an even steeper pyramid than exists on the management side. For example, in one company which prides itself on its recognition of technical excellence, 83% of those on the technical ladder are at the first point of that progression as compared to only 42% of those on the managerial

side (Epstein, 1983).[5] And this is not unusual. Indeed, many companies have positions high on their technical ladders with no people in them at all. Obviously, there is no structural necessity for this. In fact, official policy in one lab specifically states that though "the size and structure of [the lab] will determine the number at senior levels of the managerial route, there is no such inhibition in the technical route." It results, rather, from the unwillingness (or inability) to define a technical ladder that encompasses increases in responsibility and authority (Bailyn, 1982a).

There are systematic difficulties, therefore, with the technical route (cf. Gunz, 1980). In situations where it is not artificially constrained it serves as a convenient dumping ground for plateaued managers and becomes seen as clearly second rate. In those cases where it is supposedly working well, the constraints imposed limit its benefits to those most academic scientists who are primarily rewarded and motivated by their professional community. For the great bulk of the industrial lab's technical employees, who are organizationally oriented (Bailyn, 1982), the technical ladder, no matter how administered, is unlikely to serve as a challenge and reward.

The difficulties inherent in the technical ladder are problematic mainly for those R&D employees whose involvements continue to be with the actual technical work. From this point of view, any differential impact on minorities will depend on whether or not they are more or less likely to be in this group. But there is a further point to be made. Because of these difficulties, R&D employees, regardless of their orientations, tend to be pushed toward management. This, then, increases the probability of having managers whose performance is found to be lacking. To the extent that minorities are still seen as representative of a <u>class</u> of people, such <u>individual</u> mismatches may lead to stereotyped assumptions about a whole group

(cf. Laws, 1975; Kanter, 1977) which, in turn, may have self-fulfilling consequences for subsequent individuals from those groups.

From Project to Project

Of all the career routes in high technology organizations, the movement from project to project is least explicit. Generally there are no specific personnel procedures to guide this path and it seldom appears as part of official company policy. And yet, because of the constraints on movement up a managerial or technical ladder, it seems likely that a high proportion of professional employees of the R&D lab are, in fact, proceeding in this manner.

Further, McKinnon (1980) and Allen (in progress) have shown that a relatively large group (between one third and one half of the R&D professionals they surveyed) are more interested in a series of challenging research projects than they are in promotion or advancement up either a managerial or technical ladder.[6] Those who fall into this group are older and have been in their jobs longer, and are less likely to have an advanced degree. They are less concerned with either professional reputation or organizational advancement than are those who would like to move up one of the two career ladders.[7]

These are the employees who probably do the bulk of the technical work in the R&D lab. It is also the group most likely to become disgruntled and dissatisfied (Ritti, 1971; Bailyn, 1980), and to show the characteristic drop in performance associated with technical employees as they get older (Dalton and Thompson, 1971). This happens, I believe, not because of any inevitable decline with age, but because the project to project career route is poorly managed. In particular, the following organizational realities are relevant:

1. This group is most subject to salary compression: younger people come in with higher and higher starting salaries, and rates of increase tend to decrease with age.

2. This group tends to be pushed into narrow technical specialization, with resulting dangers of obsolescence (Jewkes et al., 1979) and stagnation (Katz, 1982; Bailyn, 1982a).

Both of these factors actually contribute to the decline that they seemingly only reflect.

In order to keep this group productive and satisfied, work assignments must involve new challenges and perhaps even new technologies. In one company, for example, the computer regularly identified those technical employees who had been in their current assignments for more than four years, and personal attention was then given to their development. In another case, a company insisted (by monitoring and evaluation) that 10% of each employee's time be spent learning a new technology, which then would lead to a different project assignment. Further, reward systems must be devised that assume continued high performance by this group instead of projecting the opposite assumption. That employees do adjust to what they perceive is expected of them is evident by the following comment of an R&D professional:

> The flattening of the salary curve assumes that older scientists and engineers are less productive. And since salary is the dominant mechanism, they are forced into being less productive.

The project to project route may present the least differential impact on minorities of any of the high technology career paths. Only if there is a different proportion of minorities who share this orientation would such a differential impact exist. Therefore, as has already been indicated, it is important to establish the distribution of career orientations among minority professionals.

Technical Transfer Route

By transferring with technology, the employee crosses the boundary of the central R&D lab and joins a production or operating division of the corporation. It is recommended by the R&D lab as a useful career move because it benefits both the individual (by greatly increasing available opportunities) and the company (by smoothing the transition from research to production). But despite these obvious advantages, it is usually not part of any systematically defined career path. Both structural and attitudinal factors get in the way.

R&D employees, the scientists more than the engineers, often do not fit into the structure of other divisions. Their salaries, particularly if they are Ph.D.s, may be too high, and employees at their level in other parts of the company may have too large a management responsibility. These structural factors make it difficult for professionals to follow the technical transfer route. It is of interest, though, that technicians and technical professionals use this route more frequently because they can qualify as associates in almost any other part of the company.

Such a move also requires a change in attitude on the part of R&D employees. In one lab where this path was officially recognized and where policy specifically stated that "such a move should not be thought of as irreversible," the perception was quite different. It was seen, in fact, as a "one-way valve," a "different career." And the assumed pressure and lack of flexibility in production, as opposed to research, deterred R&D employees from trying something they perceived to be irreversible.

Further, I found no company that had a systematic way of managing such moves. On the contrary, transfer arrangements are usually quite ad hoc and

must be individually negotiated. Success on this route, therefore, depends on establishing contacts in other parts of the corporation and on making oneself visible and palatable to a production unit.[8]

An example of the successful use of this route is the 47-year-old engineer in an electronics lab who wanted to move to another location. He negotiated with his supervisor to shift from being a design engineer to a product engineering job so that he could develop the skills he would need to be transferred to a production facility opening up in the area where he wanted to live. And though he used to get "real satisfaction" from designing--"an interesting job because you work from beginning to end and you see everything"--he saw the production work as an "interesting new challenge." His subsequent transfer to the production unit was accompanied by a promotion to supervisor. He is more satisfied and because of his design experience is able to be particularly useful in the new job.

To the extent that such a career route depends on individual negotiation based on information acquired through informal contacts throughout the company, minorities, for reasons already mentioned, may find this route problematic. On the other hand, if R&D employees can find a niche in production units they often are able to progress to levels that would have been closed to them in the R&D lab. Therefore, to start in R&D and then make the effort to move into another unit might provide better opportunities for career oriented minorities than the lab itself.

* * * * * * * *

There are a number of ways, therefore, to pursue R&D careers. Some are better defined than others, some are seen as more or less "successful." All, however, contain ambiguities and contradictions (cf. Bailyn, 1982b). A

possible way of dealing with these issues will be suggested in the concluding section, after looking at the case of a black engineer in one such lab.

Nathaniel Smith: A Case Study

Nathaniel Smith is a 28-year-old black mechanical engineer with a Master's degree who has worked for five years in a systems engineering lab, part of a central R&D facility of a large successful corporation.* He is one of seven professionals in his department but the only one in his supervisory group, which consists of himself and three senior technicians (all older than he), and is supervised by a 52-year-old engineer who has been a supervisor for almost twenty years. He shares an office with one of the senior technicians but spends most of his time in a distant lab that is "very noisy, and I get grease all over my fingers, and cannot keep it clean."

The work of this group is described as "routine" and "mature." In Nathaniel Smith's words:

> I think it will die out in five to eight years. Of course there will always be a group there, but the chances of promotion or recognition from that group will be nil.

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*In the four departments of this facility for which I have data there are 13 supervisors and 47 professionals. All 13 supervisors are white males, as are 35 of the professionals. The other 12 distribute as follows:

6 Asian males
1 Asian female
2 white females
3 black males

Except for Nathaniel Smith and the two white females, all of these have Ph.D.s.

And so he is investigating other departments, looking for "another area with more challenge, a management area where they are looking to promote people." But since he is the only professional in his group he feels it would be difficult to transfer: his supervisor would be reluctant to let him go.

He is also worried about his record, since he was not given a merit raise last year. The reason was that he had not "written anything." They do not have enough support people, he explained, so he spent eight months of last year in his lab and "With eight months in the lab it is hard to get time to do any writing of memoranda or technical memos."

He had encountered difficulties in getting his Master's degree. He joined the R&D lab with an undergraduate degree from Purdue and returned there when the company gave him a year's leave to pursue more education. But it turned into a disaster: "It was *killing me . . . they were tough* courses and it was too much." During his first semester his mother died, and after he took a week off he was never able to catch up. If he caught up with one course he was behind in another. He also had a "Run-in with personal problems" with his professors. He became so frustrated that he gave up:

> So I gave up and came back and explained the situation to the people here and I think they understood, but it may have held me back . . . I wonder if it hurt my career. At any rate, it was a tough road.

Eventually he got his degree at a local university while continuing to work.

Just recently he has formed an interest group, modeled on one in another lab, of all black professionals in his facility.* His reasons for forming this group summarize his perception of the situation of minorities in his company and the constraints on their careers:

*According to Smith there are about 25 blacks in all.

> Not everyone is interested in joining the group. Those that have been here just a short time think that if they just do their technical work well they will get promoted, but that is not the way it works. So we are forming this group to tell people how one gets promoted. Other locations have such groups. I think that white professionals have an easier chance to get promoted because there are more of them and also because more information is shared with them. They have their buddies. But there are few black supervisors, so there are few people to tell you what to do to get promoted. And since it is very competitive, this information is not shared. It is easier for whites because of the numbers and because they have access to information from management. The one black I know who got promoted knew someone at [corporate headquarters] who told him about a job. You need a network. It is all politics . . . exposure. You have to write technical memos in order to get your name exposed.

But such activities take time and effort:

> Another problem for blacks is that they are expected to handle the affirmative action activities. I am chairperson of my area committee. But I have a job to do and this takes time away from it. We shouldn't have to deal with this. It is company policy and the department head should be responsible, but sometimes they just pay lip service to it.

In other words, Nathaniel Smith feels torn. On the one hand, he is aware of the importance of a network for job opportunities and realizes that it will take special efforts to get this going for minorities. He knows one lab, for example, that has had a very good record of black promotions:

> They have a network, the interest group idea started there. They tell people what to do, to take courses--some on the management level. They tell them that it is not enough just to do your job every day.

At the same time, he is also aware that it is the exposure through technical memos that will most enhance his own prospects for advancement and that his involvement with the black interest group and with affirmative action takes time away from this work.

And so he contemplates his future career. He reports a high attrition among minorities, but is not inclined, at this point, to look for employment in another company:

> Nothing happens [here], but sometimes it is the same in other organizations. I have a brother who worked here and then quit to go to another company and says it is the same thing.

Also, he feels that he has time invested in the company, as well as benefits and money:

> I have not thought about it. I am still young, only 28, and could still move. But if push comes to shove, if I have to, I will go.

Commentary. Nathaniel Smith is in a difficult position. Not only is he in a group that is not well situated to further his career ambitions, but he is also spending time and effort on activities that have no direct relation to his career. Indirectly, of course, these activities may be of help. But it is his immediate situation in the group in which he works that creates the most serious stumbling block for him. Not only is he working in a "mature" technology ("sexy technology gets more attention"), but his supervisor is not one to push his advancement.

Nathaniel Smith's supervisor is a perfect example of what happens when promotion to management is the only reward for technical excellence. His situation was described, by someone who knows him well, in the following way:

> He was promoted because he is a terrific engineer. He was pushed into supervision. He could have refused, but everybody accepts because of salary and prestige. But he finds it hard to let go of the day to day tasks . . . He can't let go of the engineering tasks . . . Other groups work differently, people have more responsibility . . . It is not intentional, but he is so involved. He loves the work so much that he can't stop himself.

The effect on the group, however, is demoralizing:

> He is the type of person who should not be a supervisor because he is only technical. He should be a senior scientist on a dual ladder. That's where he should be because he has no rapport with people. He has no confidence in his people, he can't let them do it. He redoes all their calculations, he has no trust. He is very technically competent so he checks them. That is ridiculous.

And the supervisor himself is aware of this difficulty:

> I feel that my own role is probably too strong technically and not strong enough administratively.

The situation is exacerbated, according to Smith, by the style of management of the department head to whom this supervisor reports:

> He [the department head] is too nice. He can't tell people what to do. He likes to leave his supervisors alone, but it is his responsibility to tell them about problems and he won't do it. It depends on the management how far you will go. If management is dynamic you are going to move; if they back down then it is no good. At grade time you are rated against others at the same level and with the same number of years, and if management doesn't back you, you will lose money. The allocation is determined centrally, but who gets more or less depends on these joint meetings.

It is a style of management that is very consciously pursued by the department head, who explained to me that he likes his supervisors to be prime movers in terms of ideas and then he wants them to carry them out. In particular, about Nathaniel Smith's group, he commented as follows:

> It is a mature technology and the people in it are long-time people. What that means is that it has a low change rate and that advances have slowed down, and that the technology has been around for some time. The supervisor is very imaginative and now, with new advances, the area may be moving more technologically.

Unfortunately, the movement is toward electronics and away from the mechanical engineering in which Nathaniel Smith is trained.

There are, of course, other people who find themselves in such a situation, and it is hard to know to what extent Nathaniel Smith's minority status has played a role. I have no information about how he got assigned to this group when he first came. I do know, however, that it is unusual in this lab to be the only professional in a group.* And since the characteristics of his supervisor are known, an assignment sensitive to minority concerns would not have put a black in this group. Further, to the extent that his involvement with the black interest group and with affirmative action detracts from his ability to produce the memos that will further his career, he is directly hindered by his minority status.

Conclusions

Nathaniel Smith is pursuing a career in high technology. The settings in which such careers unfold have characteristics of which one must be aware in order to understand his situation. These factors may be summarized in four points:

1. There are no unambiguous, agreed upon criteria by which to gauge a particular individual's performance.
2. Initial judgments (and some subsequent ones) are based on academic criteria.
3. It is difficult to describe, learn, or teach the best way to meet the requirements of the tasks to be performed, since such knowledge is characteristically tacit and depends on understanding and maneuvering in the informal organization.
4. There are contradictions embedded in technical career paths and career procedures that make it difficult for individuals to get accurate self-understanding and to shape their careers appropriately.[9]

*It should be stated that his degree in mechanical engineering is also unusual, since a large majority of the lab's employees come either from EE or from physics.

The best way to deal with these issues will obviously depend on the particular character of the specific organization in question. Still, some general considerations are possible. But further research will also be needed for in order to ensure equitable treatment for all individuals in these situations certain empirical questions require an answer. The final section of this paper briefly sketches some of these implications.

Implications for Organizational Career Procedures

The main idea I would like to suggest here is the possibility of a hybrid career in high technology, one which encompasses aspects of all the career routes described above. To make this work, one would have to think of individuals' tasks in terms of multiple work assignments, each with different forms of evaluation and reward; and, one would have to consider careers in terms of discrete, discontinuous chunks.

Even though the technical work force is, almost by definition, specialized--and technical specialists play an important role in high technology--the assumption behind multiple work assignments is that over-specialization must be avoided. To achieve this, professionals must be forced to develop "minors"--areas of knowledge and competence outside of their major specialization. Two kinds of approaches are possible: first, temporary assignments (perhaps 6-18 months) to a new setting or task; and second, partial assignments that run concurrently with one's main work. The latter have already been alluded to in the example of the company that mandated 10% of each employee's time to the learning of a new technology. But other partial assignments are also possible: though mainly in research, an

assignment might call for a certain proportion of time on development, or a design assignment could be accompanied by responsibility for "continuing" engineering for a product already in production. Such assignments could serve important boundary-spanning functions: from research, for example, to production or administration. Participation in QWL or QC efforts is another example. In all cases the outcome would be more integration for the company and less probability of stagnation and obsolescence for the individual.

Similar functions are served by temporary assignments to altogether different tasks, perhaps to a different setting. In one company, for example, there was great resistance by one unit to implementing a new system that had been proven to be highly efficient and cost effective. The chief engineer in the R&D lab of the company--who had been "relieved" of a management position--felt that he could be useful in this situation by spending six months in the production company involved in order to help them implement the new system which he had helped design. But there were constraints in the way: he did not want to make a permanent move, management feared that a temporary assignment would preclude a permanent solution, etc. Clearly, the notion of temporary assignments was not part of the accepted procedures of this organization, even though it was an obvious answer, in this case, to a troublesome organizational impasse.

Such multiple work assignments would also serve the purpose of preparing the person for the next career chunk. The notion of career chunk is similar to that of a temporary assignment but of longer duration: typically five to ten years. I think of career chunks as preplanned, discontinuous periods of a career, each of which may have a very different major assignment. So, an individual may be involved for one chunk in a long range, perhaps risky technical effort: an IBM Fellow is an example. This may be followed by a

chunk in management; or by a more programmed technical task assignment. At each stage the technical employee would carry, also, some secondary assignments for the purposes already stated. The important point is that because they are preplanned, such discontinuities would not be seen as failures. The chief engineer mentioned above underwent such a transition. But since the underlying assumption had been that once in management, always in management, he perceived this as a failure and it took some time before he began again to function effectively.

The hybrid career, therefore, would allow people to move easily among the various career routes: both sequentially and concurrently. It has obvious implications for career procedures. First, it presumes a disaggregation of status and salary from task. It would mean, also, that no particular assignment, such as the supervision of a group, could be given as a reward for good performance in a different task. Finally, there are implications for evaluation: rather than a uniform system of performance review, it would be necessary to establish a variety of evaluative procedures to fit different periods of the career and different aspects of the work assigned at any given time (cf. Bailyn, 1984).

The question would still remain, however, whether hybrid careers would pose special problems for minorities.

Implications for Future Research

The analysis of this paper points to a number of empirical questions for future research. In particular, the following seem to me of greatest importance (starting with those that have already been indicated):

1. How does the distribution of motivations for technical careers among non-traditional employees compare with that of the traditional workforce?[10]

2. How do technical professionals acquire the information necessary for the formation of career anchors, and are these feedback processes different for non-traditional and traditional employees?

3. What are the decision rules by which recruits are initially assigned to groups and subsequently moved, and are these different for traditional and non-traditional workers?

4. Under what conditions, and at what levels, do employees from non-traditional backgrounds have an easier or more difficult time in deciphering the informal rules governing effective behavior in high technology organizations?

5. What characteristics--of individuals and settings--allow people to take advantage of ambiguity, and what interventions--in terms of training or modified conditions of work--might facilitate this ability?

It is clear that there would be no simple way to answer these questions. Research along these lines would take time and would have to depend on a variety of approaches. But it is only by confronting the complex interactions among individual characteristics, such as race, organizational career procedures, and the variety of tasks involved in technical work, I believe, that we will be able to gain the understanding necessary to ensure equity for all who desire careers in high technology.

NOTES

1. I have noticed one other recruitment issue that should be mentioned, though my evidence relates to women and I do not know if the same is true for minorities. In an effort to recruit more women, some of the technical organizations in which I worked reduced the formal credentials required for hiring. In a number of cases I found women with Master's degrees in a group where all the other members had Ph.D's. Their work was not affected--indeed, in these particular cases they were seen as unusually competent. But degree entered into the formula for deciding on salaries and promotions. It is possible, therefore, that this attempt to bring in more women will backfire when it comes to ensuring that they make equal progress in subsequent stages of their careers.

2. One interesting point that emerged from my data is that autonomy, a hallmark of the professions, is not usually a dominant motivation for technically trained people who enter industry (Bailyn, 1982b). This has long been known for engineers (Ritti, 1971; Kerr et al., 1977; Bailyn, 1980) but was true even of the Ph.D. scientists in R&D labs whom I interviewed.

3. This is particularly true of engineering. David Riesman once remarked that sons of engineers don't become engineers. What was interesting in the organizations in which I worked was that daughters of engineers do. It seems that the selection principles for technically trained women (both self and organizational) are such that many enter the career because they are daughters of engineers and their initial motivations are much more skewed toward technical involvement than is true for men. This has obvious implications for future career progression, since, ironically, it is the technically involved engineers for whom the career is most problematic. My guess is that this will be an issue only for minority women, with minority men following a distribution of initial involvements more similar to white men.

4. There is some evidence, for example, that women are less likely than men to have clearly defined career anchors (Schein, 1982).

5. It often also creates an inverse pyramid below the dividing point, bunching professionals in the last position before a clear move into management or to high level technical positions must occur.

6. Informal evidence from the R&D labs I studied indicates that a considerably higher proportion of female employees fall into this group.

7. Because these results are based on cross-sectional data, it is hard to know to what extent this orientation is merely an adaptation to lack of movement in an organization. Longitudinal data on mid-career engineers (Bailyn and Lynch, 1983) have shown that orientations are indeed responsive to particular career experiences. Nonetheless, because of the numbers involved, it is likely that there is more here than merely a rationalization for organizational "failure" and that the movement from project to project represents a genuine career orientation which warrants an explicitly managed career path in high technology.

8. Just as R&D employees tend to look down on production work, so the personnel of the operating divisions tend to be suspicious of the usefulness, for their purposes, of research workers.

9. Some companies, which pride themselves on a "consistent personnel policy," exacerbate these conditions by insisting on procedures that were developed for very different kinds of tasks: for tasks that can be easily described, monitored and evaluated, and fit neatly into an hierarchical scheme.

10. By "traditional" I mean the group that has filled the majority of these positions in the past--in this case white males, and maybe only those with traditional family support systems. All others, including minorities, women, and, perhaps, white men in dual career families, are categorized as "non-traditional" (cf. Bailyn, 1984). (These groups would, of course, be kept separate in any analysis.)

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